Appendix II

Baseline Scenarios for a California Energy Commission Study of the Potential Effects of Climate Change on California: Summary of a June 12, 2000, Workshop

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1. Introduction

Experts from the California impact team**,** agency representatives from the State of California; and researchers from U.S. Department of Energy (DOE) laboratories, universities, and research institutions in California gathered in Sacramento on the morning of June 12, 2000, to decide what baseline scenarios should be used in the global warming study of California (an attachment to this appendix lists these participants). The study was designed to measure the impacts of several climate scenarios on California in 2020, 2060, and 2100. Because these climate impacts occur well into the future, we needed to discuss what California might look like by these dates. So-called baseline changes in California's population, level of development, economy, and environment could dramatically change the state's sensitivity to climate change. Because there are tremendous uncertainties about future development, the meeting organizers proposed that we consider two scenarios of baseline changes to capture some of the variance in baseline changes. The purpose of this meeting was to determine what those two scenarios should be.

Looking into the future is difficult, and all the participants agreed that projections for the future would be highly uncertain. Factors that cannot be foreseen could have an impact on the path of California's development. Projecting future immigration, demography, economic production (for the state and for the world), technology, urbanization, transportation, pollution, and demand for environmental services is not easy. Sectoral changes such as changes in urban and agricultural demand for water, agricultural productivity, timber production, coastal development, and recreation are also difficult to foresee. It is not possible to capture all these uncertainties in only two scenarios. Nor are these scenarios intended for use as predictions of future conditions in California. Their main function is to help us understand how the state's sensitivity to climate change might change over time.

The group decided to try to create two distinct scenarios for the entire state (Table 1). The scenarios would not dictate specific sectoral changes. Instead, sector-specific assumptions and sensitivity studies were left to the authors of the sector studies to decide. The analysts for each sector were instructed to make sectoral assumptions that would be consistent with the statewide projections.

Consequently, the group focused on the most important future parameters, which we identified as population growth rates and growth in per capita income in California. Environmental trends were identified as a third general category of factors that could significantly affect the climate sensitivity of several economic sectors.

Table 1. Growth scenarios

	Year			
Variable	**2000**	**2020**	**2060**	**2100**
Low population-growth scenario				
Population (million)	35	45	50	50
Income per capita (000, $)	40	60	90	134
Urban size (000,000 ha)	1.5	1.7	1.8	1.8
Environmental demand	Moderate	High	High	High
High population-growth scenario				
Population	35	50	70	90
Income per capita	40	48	60	73
Urban size	1.5	1.8	2.2	2.6
Environmental demand	Moderate	Moderate	Moderate	Moderate

2. Population

Population forecasts for California are particularly difficult to make because they combine demographic changes in the existing population with net migration. It is relatively easy to project how births and deaths may change in the near future because they are largely determined by the existing population's age distribution. However, the further into the future we project, the more important the future birth and death rates become. If these rates change dramatically from current experience, the future population could look quite different by 2060, and vastly different by 2100. Projecting changes in net migration over time is also complicated. If future U.S. income far outstrips the per capita income of Latin America, for example, there may be tremendous pressure for net migration into California. Under this scenario, the state would certainly continue to grow. In contrast, if Latin America develops quickly, this pressure may evaporate and the state's population could stabilize.

To capture these two dramatic population situations, we recommended one high and one low population-growth scenario. The high population-growth scenario assumes that California's population, which has grown by 500,000 people per year (5 million per decade) since World War II, would continue to grow at that rate through the next century. The high scenario predicts that this would continue through 2100. In this scenario, the state population would expand to 90 million by 2100. The low population-growth scenario projects that this growth path would slow over time and eventually stabilize at 50 million. In the low scenario, the population would reach 45 million by 2020, and then gradually approach 50 million by 2060, when it would stabilize. These two scenarios were designed to test whether the size of the state's future population is important in determining California's climate sensitivity. Readers should not overinterpret the assumptions and assume that these are the only two possible futures for California. However, these population projections are consistent with estimates made by others in the state (e.g., Johnson, 1999).

3. Economic Growth

The group spent a great deal of time discussing what economic scenarios should be coupled with these population projections. The scenario with relatively low future population growth was seen as a likely foundation for more rapid economic growth. Given historical rates of growth during the last century — 2% in developed countries — it seemed reasonable to assume that a 2% growth rate for California per capita income could continue for the next century in the low population-growth scenario. At first, we discussed the possibility that the high population-growth scenario should also be coupled with high per capita income growth. However, it became clear that it would be more plausible to couple high population growth with low per capita income growth. Under this scenario, we imagined that the net migration necessary to fuel continued high population growth would more likely involve relatively poor immigrants and possibly outmigration of wealthy citizens. For this reason, we decided to assume that the high population-growth scenario would include reduced per capita income growth. A reasonable low income-growth rate would be 1% per year, which is half that of the high-growth scenario. The group consequently decided to marry high population-growth rates with low per capita income growth and low population-growth rates with high per capita income growth.

John Landis of the University of California, Berkeley, projected that for every 500,000 new people, the state would need 220,000 additional housing units. Projecting that future populations would continue to live in urban areas in California (currently 92% are urban), he went on to say that urban areas would have to grow by about 10,000 hectares (25,000 acres) a year to accommodate 500,000 new inhabitants. Professor Landis theorized that new residents will want to come to existing urban areas approximately in proportion to their current size; that is, more people will be drawn to southern (60%) than northern (40%) California, and more people will be drawn to Los Angeles than any other city. However, Dr. Landis also noted that available land for new housing is quite limited in three counties (Los Angeles, Orange, and San Francisco). As a result, growth will be pushed out to surrounding communities such as the San Joaquin valley and the area near San Bernardino. Although the outgrowth of urban areas could intrude into land with low agricultural value near the foothills of these valleys, it is not expected to take over the fertile central lowlands.

4. Environment

We anticipated that the conditions under both scenarios would affect pollution. The high population-growth, low income-growth scenario would most likely put the greatest pressure on emissions. However, we assumed that pollution abatement would keep pace with emissions in this case and that current conditions would continue, except perhaps in high-growth areas. We assumed that the low population-growth scenario would be accompanied by an improvement in pollution control, reasoning that higher incomes would increase the desire for high air and water quality and lead to stricter standards and improved conditions.

The demand for environmental services would also be affected under each scenario. We assumed that the high income-growth scenario would lead to an increased demand for environmental services. In the water sector, that would translate to an increased level of restrictions to protect in-stream use and recreation. In the management of forests, this scenario would also call for more protected lands for recreation and conservation. In contrast, we assumed that the low income-growth scenario would simply continue the demand for environmental services at the current level. The desire for economic growth would counterbalance the desire for environmental services in this scenario, leaving restrictions at their current levels.

5. Sector-Specific Guidelines

We decided that the analysts for the individual sectors should make scenario assumptions that are consistent with the assumptions described here. For example, the investigator for the coastal study should assume that there would be pressure to continue development along the coast. The low population-growth scenario would see pressure from the expected growth in per capita income. The high population-growth scenario would maintain pressure just to locate enough homes for the large projected population. In examining agriculture, the analyst should account for the population growth of the high-growth scenario because that will intrude on low-value agricultural land. The projection of land use should accommodate the expected population growth in the foothills. The rapid growth in the urban demand for water should be accounted for in the high population-growth scenario.

Those conducting the individual sector studies should examine the sensitivity of their results to their sector-specific assumptions independently of the two economic baseline scenarios. For example, the water study investigator might want to examine the importance of possible shifts in the demand for water by crops and people because of new technology. In the agricultural study, it might be appropriate to examine the sensitivity of the results to assumptions about the growth in crop productivity over time. The water study analyst might want to consider the importance of a possible shift from single family to multifamily dwellings.

Reference

Johnson, H. 1999. How many Californians? *California Counts*: 1. Public Policy Institute of California, San Francisco. Available at http://www.ppic.org/publications/CalCounts1/calcounts1.pdf.

Appendix II — Attachment

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